to personal observation and inquiry extending from Connecticut to as far north as Hamilton Inlet in Labrador. The biology of the subject relates not so much to the habits of *Salmo salar* as it does to the behavior of *Homo sapiens*—with his specific appellation self-chosen.

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EFFICIENCY IN THERMAL PHENOMENA

To the Editor of Science: Mr. Forbes's theory of something being wrong with the commonly accepted definitions of efficiency in thermal phenomena, is provocative of comment. The question of a definition being wrong depends, obviously, on how it is interpreted.

In general the efficiency of a machine or mechanical process, is defined as the ratio of output to input. It is assumed that the output will always be less than the input, hence the efficiency will be less than unity.

It is safe to say that the difficulties alluded to by Mr. Forbes can be traced to failure to distinguish between the quantities of energy called input and output, and the units in which they are measured. In the electric heater, the input, watts, is wholly converted into heat, with efficiency of 100 per cent. In the electric motor the input, watts, is converted into 95 per cent. work and five per cent. heat, giving 95 per cent. efficiency if work output is considered, and 100 per cent. efficiency for the entire output. In the steam engine the input, heat, is converted into ten per cent. work and 90 per cent. heat, giving an efficiency of ten per cent. based on work output, 90 per cent. efficiency based on the exhaust steam for heating, and 100 per cent. for the entire output. In the refrigerating machine the output is, logically, heat carried away by the condenser water. The input, on the same reasoning, is made up of two parts, the heat removed from the brine and the work of driving the machine. The sum of the two input quantities is equal to the output, giving 100 per cent. efficiency as in all the other cases.

The refrigerating engineer recognizes the difficulty of applying the term efficiency to his machine, and substitutes for it the term "coefficient of performance," the ratio of heat absorbed to the work required to drive the machine, both expressed in the same units.

If efficiency is defined by the input-output formula, it is true that the efficiency of all machines is 100 per cent. If only a portion of the input or output is considered, it is possible to have efficiencies of less or more than 100 per cent. In this case it would be appropriate to use the term "partial efficiency," since the entire output is not considered.

E. H. Lockwood

THE HELIUM ARC AS A GENERATOR OF HIGH FREQUENCY OSCILLATIONS

Helium as a conducting medium in a low-voltage arc may be of considerable utility as a convenient source for generating, from direct current, oscillations of moderately high frequency.

Due to its exceptionally low sparking potential arcs may be readily started from a hot tungsten cathode by 110 volts even when the gas is at atmospheric pressure. In fact it is easy to start the arc across a centimeter gap between cold electrodes by means of breaking a parallel circuit with a series reactance common to both. Perhaps a more convenient method of starting, however, is the heating of the filament by the source of supply and then a commutation of the connection to the positive terminal from the filament to the anode.

When the proper inductance and capacity are connected across the arc high frequency oscillations are produced which may be utilized in the usual way with a coupled circuit. Hitherto, hydrogen and compounds of hydrogen have been used in areas to produce high frequency and it is very difficult to produce oscillations by the use of other gases at atmospheric pressure. Helium, however, probably due to its high heat conductivity, being inferior only to hydrogen in this respect, from the rapid rate of energy dissipation in the arc, gives the type of volt ampere